

Original Article

The Attention-Getting Capacity of Whines and Child-Directed Speech

Rosemarie Sokol Chang, Department of Psychology, State University of New York at New Paltz, New Paltz, USA. Email: rischang@gmail.com (Corresponding author).

Nicholas S. Thompson, Department of Psychology, Clark University, Worcester, USA.

Abstract: The current study tested the ability of whines and child-directed speech to attract the attention of listeners involved in a story repetition task. Twenty non-parents and 17 parents were presented with two dull stories, each playing to a separate ear, and asked to repeat one of the stories verbatim. The story that participants were instructed to ignore was interrupted occasionally with the reader whining and using child-directed speech. While repeating the passage, participants were monitored for Galvanic skin response, heart rate, and blood pressure. Based on 4 measures, participants tuned in more to whining, and to a lesser extent child-directed speech, than neutral speech segments that served as a control. Participants, regardless of gender or parental status, made more mistakes when presented with the whine or child-directed speech, they recalled hearing those vocalizations, they recognized more words from the whining segment than the neutral control segment, and they exhibited higher Galvanic skin response during the presence of whines and child-directed speech than neutral speech segments. Whines and child-directed speech appear to be integral members of a suite of vocalizations designed to get the attention of attachment partners by playing to an auditory sensitivity among humans. Whines in particular may serve the function of eliciting care at a time when caregivers switch from primarily mothers to greater care from other caregivers.

Keywords: Whining, child-directed speech, parental investment, attachment vocalizations, attention, psychophysiology.

Introduction

Attachment is a mutual regulatory relation between caregiver and child (Bowlby, 1969/1982). This relationship is constituted by behaviors that alter the proximity between caregivers and care receivers. Depending on the circumstances, a given attachment behavior may provoke engagement or disengagement by either or both partners. The caregiver is regulated by cues that she receives from the infant, such as cues of hunger,

distress, health, and the infant's willingness to explore. The infant is regulated by cues that he receives from the caregiver, such cues to danger and to her attentiveness. The predictable outcome of these regulations is the decreased proximity between the infant and caregiver as they pursue somewhat independent activities (Bowlby, 1969/1982: 124).

The exchange of vocalizations is an important feature of the human attachment relation (e.g. Bowlby, 1969/1982; Falk, 2009). The first attachment vocalization to appear is crying. Cries are effective at provoking a response from a caregiver, particularly mothers (Brewster et al., 1998; Zeskind and Shingler, 1991). Infant cries are most effective when they exhibit rising pitch and more varied pitch contours (Dessureau, Olson, and Thompson, 1998; Gustafson and Green, 1989; Robb, Saxman, and Grant, 1989; Thompson, Olson, and Dessureau 1996; Thompson, Dessureau, and Olson, 1998; Zeskind and Lester, 1978). Specifically, Crowe and Zeskind (1992) proposed pitch and phonation as crucial features of infant cries. A vocalization is phonated when the vocal cords open and close regularly, and phonation corresponds to the perceptual variable of vocal clarity. Typical phonated cries have a fundamental frequency averaging 450-600 hertz; "hyperphonated" cries typically average between 1000-2000 hertz. Crowe and Zeskind (1992) explored the possibility that hyperphonation is a powerful elicitor of adult response. Hyperphonation is often characteristic of cries from low birth weight infants, preterm infants, and other infants who show signs of high-risk medical problems (Crowe and Zeskind, 1992; LaGasse, Neal, and Lester, 2005). Hyperphonated cries appear to elicit high arousal in adults, as shown by their skin conductance levels and changes in heart rate.

In response to cries and other infant behaviors, caregivers frequently regulate children with child-directed speech (CDS). Compared to the more neutral sounding prosody of adult-directed speech (ADS), CDS contains more extreme pitch variations, higher pitch, and elongation of vowel sounds. These salient acoustic features of CDS grab the infant's attention (Fernald, 1992a and 1992b; Papoušek, et al., 2000) and facilitate the infant's ability to appropriately respond to affective cues (Fernald and Mazzie, 1991; Trainor, Austin and Desjardins, 2000). When confronted with either a recording of CDS or ADS, infants attend more to the CDS recordings (see Fernald, 1992b for a cross-cultural review; see also Gogate, Bahrick, and Watson, 2000 for a multimodal examination of CDS). This finding is also stable whether CDS is used by a male or female.

Infants respond to variations in the prosody of CDS (Fernald, 1992b; Papoušek, et al., 2000). A caregiver uses either slow, rising pitch contours to get an infant's attention, consistent rising-falling contours to encourage him, slow falling pitch contours to soothe him, and fast falling contours to inhibit potentially dangerous behavior. Infants appear to recognize the difference in these patterns, most notably differentiating the warning patterns from the other patterns early in infancy and responding defensively (Fernald, 1993; Kearsley, 1973; Mumme, Fernald, and Herrera, 1996). Thus, there is a relationship between the form of CDS and the specific type of attachment regulating function that it serves.

The third vocalization in this attachment repertoire is whining. Whining is a vocalization, often coupled with speech, that is used to make a request, lodge a complaint, or represent discontent¹. Whining shares with CDS, and to a lesser extent infant cries, the specialized acoustic characteristics of increased pitch, varied pitch patterns (the rise and fall of speech), and slow production in relation to other human vocalizations (Fernald, 1992b;

¹ For an audio sample of an adult whining in Hindi, please visit <http://newpaltz.edu/~changr/AdultWhine.mov>
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Sokol, Webster, Thompson and Stevens, 2005). Further, whines display higher average intensity (perceived as energy, or loudness) than related vocalizations. The structural similarity of whines and CDS has been documented repeatedly in previous studies (Lescak et al., 2006; Sokol et al., 2005; Webster, 2005). Each serves as a unique alteration of prosody that changes or reinforces the meaning of the linguistic content of the speech. Male and female judges both rate whining as more annoying than other types of speech (Sokol et al., 2005).

Whining begins to take the place of crying during the transition from infancy to childhood. Peaking between 2-4 years (Borba, 2003; Sears and Sears, 1995), whining becomes more prominent as the child becomes more physically independent and linguistically competent. Whining has the potential to convey a more specific message to the listener than does crying. A child might request a particular object, such as food, or make a specific refusal, such as refusing to go where the caregiver wishes.

Whining peaks at the traditional time of weaning, which is often cited as a major catalyst of parent-offspring conflict. Parent-offspring conflict occurs when a caregiver and offspring disagree over the amount of investment a caregiver should confer (Trivers, 1974). This conflict peaks when benefits currently provided to the present offspring would produce more fitness gains for the mother if provided to the next offspring and it tails off when the additional fitness gains for the present offspring are more than offset by the damage done to future siblings. However, this traditional account of weaning conflict does not adequately take into account the extraordinary dependence of a human weanling on the adults around him. Thus parent-offspring conflict in humans is not about negotiating a cessation of maternal care but about a relatively subtle shift in the resources dedicated to the weanling. Before weaning, those resources are primarily nutrients provided by breast milk; after weaning the nutrients conferred are solid foods.

With this nutritional switch, the potential for others to share investment in the child are heightened. Hrdy (2009) has stressed the importance of alloparenting to the development of human offspring. As young as 3-4 months old, alloparents from traditional societies are noted to feed pre-masticated food to infants, and as the child progresses to finger foods (around the age of peak whining!), they are given nuts and roots collected and prepared by grandmothers and aunts, and meat and honey brought by fathers, uncles, and other hunters. That whines arise in a transition to greater alloparental care implies that adults, regardless of gender or parental status, should be equally affected by whining.

Measures of Attention

An initial step in determining the evolved function of whining given these developmental transitions is to test its effectiveness at eliciting attention from listeners. A previous study has established the structural similarity of whines to cries and CDS (Sokol et al., 2005). Given these similarities, whining should also exhibit the attention-getting capacity of infant cries and CDS.

Whining has already been shown to have as much or greater power as crying and CDS to distract adults from a simple rote task (Sokol and Thompson, 2005). Male and female participants, both with and without young children, were presented with a whine, a cry, CDS, machine noise, neutral speech (adult-directed speech), and silence all while completing simple math problems. All participants were most distracted, as measured by number of problems completed, when listening to the whines, followed by infant cries, then

CDS. All participants were more distracted by whines than the machine noise and neutral speech. Notably, the machine noise was both loud and exhibited high pitch.

This distraction study shows that whining and the other attachment vocalizations have the power to draw attention away from a task, but do not demonstrate that they have the power to draw attention to the whiner. To measure the attention-getting properties of whines and CDS, we considered the dichotic listening task. The dichotic listening task has traditionally been used to test the auditory attention of listeners when presented with competing auditory stimuli. In addition, we considered physiological measures, which have been used to test bodily changes in response to stimuli, in this case particularly auditory stimuli.

The dichotic listening task was devised to test the auditory attention of individuals. Cherry (1953) devised the task to examine what he termed the “cocktail party phenomenon” – that people can, and often do, pay attention to one conversation in the midst of many competing conversations. To test this effect, he designed a task in which participants are presented with a different spoken passage in each ear. Participants are instructed to listen to and repeat one passage, a task referred to as “shadowing”. Shadowing in this context refers specifically to the following and repetition of a passage played to one ear, only. Participants are instructed to ignore the passage playing to the other ear, which simultaneously plays a competing story. For this original version of dichotic listening, participants were tested for their ability to recognize that their names had been inserted into the non-shadowed passage, a task that only one-third of the participants successfully completed. In such a case, the capacity for one’s name to draw one’s attention was moderate at best.

Cherry (1953) used the dichotic listening task to demonstrate the power of attention to screen out extraneous stimuli. It can, however, also be used to test the power of competing stimuli to draw attention away from the shadowing task. Cherry’s dichotic listening task produces evidence of momentary attention shifts that the participant cannot retrieve at a later time. By responding physiologically to the non-shadowed content, participants indicate that, to some degree, they have attended to the content from the non-shadowed passage (Corteen and Wood, 1972; Forster and Govier, 1978).

Hypotheses

We have four specific hypotheses related to the attention getting properties of whining and CDS relative to neutral speech. First, we propose that participants will make more speech disfluency errors when presented with the whine and CDS (test) segments of the non-shadowed passage than when presented with the neutral (control) segments in that passage. Speech disfluencies will be measured as words that are added, changed or missed when repeating the passage, as well as the amount of stuttering, laughter, or alterations of plurality. Second, we propose that participants will recognize more words from the whine and CDS portions of the passages than from the control, the non-shadowed neutral passage. Third, we predict that participants will report hearing whines and CDS in the non-shadowed passage (recall). Fourth, we predict that participants will have an increase in arousal, as measured by galvanic skin response, heart rate, and blood pressure levels, when presented with the whine and CDS segments of the non-shadowed passage than the neutral segments of that track.

Materials and Methods

Participants

There were two groups of participants for this research. The first was made up of undergraduates from Clark University and Quinsigamond Community College (10 male, 10 female), ages 17-23. This group is also termed the “non-parent” group. The second was made up of parents (7 male, 10 female), ages 31-59, with at least one child who was fourteen years of age or under at the time of testing. This group is also known as the “parent” group. The participants from this latter group are from the central Massachusetts area. The cutoff age of the children in the parent groups was based on personal reports that fourteen year olds are still frequently engaged in whining. All participants were entered into a raffle for one of four US\$50 cash prizes. The Clark University Institutional Review Board approved this research.

Stimuli

In a previous study (Lescak, 2006), whining data was collected from children. However, the children had a difficult time altering their prosody for scripted material for this study, which required demonstrators to read approximately 2-second scripts. The ideal age of demonstrators for this study would have been between 2-4 years of age, as this is when whining peaks – however, children at this age are not competent at reading scripts. Given the length of recording in this study (approximately 7 minutes, with 40-second strings of prosodic alteration), we decided to use adult demonstrators to create the stimuli.

Many recordings were collected of adult demonstrators who had previous theatre training. Demonstrators were asked to read through the stories a few times, and read them as felt natural. For each of the test segments (whining and child-directed speech), they were asked to pretend they were either pleading with a parent, or soothing an infant, respectively. Demonstrators were not aware of how the stories would be combined and used for the study. Three independent raters selected the final stimuli. Each rater has been trained to recognize the acoustic qualities of whining and child-directed speech based on past analyses (Sokol et al., 2005; Sokol and Thompson, 2005). Passages were recorded on a digital tape recorder in a noise-controlled room, with a microphone placed 12 inches from the speaker. These stimuli were controlled for volume during recording. Decibel levels were monitored on the digital recorder to ensure that the loudness of each passage was approximately the same.

The stimuli ultimately used in this study were two passages read by the same female reader. Each passage was a non-eventful story about a woman and her college experience. The first was about a woman and her scholarly activities, mostly with a local youth group. The other was about a woman and her time at college, and follows her through her marriage and motherhood. The passage that participants were instructed to attend to and repeat verbatim (the shadowed passage) was read entirely in a neutral tone of voice. This passage was 6 minutes and 59 seconds long. In addition, there was a non-shadowed passage, which participants were instructed to ignore though it played simultaneously with the shadowed passage to the opposite ear. This passage was also read in a neutral tone of voice, but around four minutes, and then 5 minutes 20 seconds into this passage, the reader begins to speak in a whine or CDS for 40 seconds each. The choice to present the first test segment at four minutes was to allow for errors in repetition to asymptote (Wood and

Cowan, 1995).

The passages were then combined into a single stereo recording so that each played into a different channel by using the software program Audacity on a PC computer (Mazzoni, 2004). For half of the participants, the shadowed passage played to the right ear, for the other half it played to the left ear. This counterbalancing was done to minimize the effects of hemispheric specialization of the interpretation of emotional speech (Best, Womer, and Queen, 1994). In addition, the presentation of the whine and CDS segments was counterbalanced so that half of the participants heard the whine segment first, and the other half heard the CDS segment first.

Dichotic Listening Task

Participants were instructed that they were participating in an attention study. They were not told what they would be hearing in order to reduce the expectation bias of types of speech used. In addition, they were told that they would be listening to and repeating a story that played to one ear, while ignoring a story simultaneously playing to the other. Participants were outfitted with a set of headphones and a clip-on microphone, and told that they would be recorded while completing the task. These recordings were done with a hand held digital voice recorder so that their speech disfluencies could be examined at a later date. They were then given the chance to adjust the volume of the audio tracks before beginning the task.

At the end of this part of the study participants were given a recall and recognition test. The recall portion included the following questions, positioned at the beginning and end of the recognition portion: “Was there any point while you were tracking the passage that you were distracted?”; and “Do you remember hearing any words from the message you did not pay attention to?” The recognition portion of the test included 64 words. Two of the words were included in both tracks. Each story told a tale about different people, and as such there were two names from the shadowed passage, two from the non-shadowed passage, and three that were not in either. The remaining words were distributed among the following groups: words unique to the shadowed passage, words unique to the whining segment, words unique to the CDS segment, and words that were not in either passage. Each of these consisted of seven words, with the exception of the CDS words, of which there were only six (see table 1).

Physiological Measurement

During the dichotic listening task, participants were connected to equipment that measured their heart rate (HR), blood pressure (BP), and galvanic skin response (GSR). HR measures were attained by an Electrocardiogram (ECG), connected via leads attached to the participant’s inner ankles and right wrist. BP was measured by a continuous read wrist cuff affixed to the left wrist. GSR was measured through electrodes placed on the participant’s first phalanx of the index and middle fingers on the left hand. All data was collected through a data acquisition system (Biopac Systems 150) and stored in a computer for later analysis.

Table 1. Uniqueness of Words Included in the Recognition Test

| Uniqueness of words.... | Words not in either passage | Words in the neutral segments of the non-shadowed passage | Words in the shadowed passage | Words in the whine segment of the non-shadowed passage | Words in the CDS segment of the non-shadowed passage |
|---|-----------------------------|---|-------------------------------|--|--|
| Among the 2000 most frequent words | 6 | 6 | 10 | 3 | 5 |
| Among the 2000-5000 most frequent words | 8 | 1 | 6 | 1 | 0 |
| Among the 5000 most frequent words and more | 7 | 2 | 5 | 3 | 1 |
| Total number of words in passage | 21 | 9 | 21 | 7 | 6 |

Note: Word uniqueness was determined by using the Most Frequent Words List from the Brown Corpus (Virtual Language Centre, 2010) (comprises 1,015,945 words with 47,218 unique words)

Statistical Analyses

Data for the dichotic listening task and physiological measures were segmented into five 40-second parts according to what the participant was hearing. These included the two test segments (whine and CDS) and comparison segments in which neutral speech played to both channels (one before the first test segment, one between each test segment, and one after the second test segment).

Dichotic listening data were coded by each segment for six different speech disfluencies, including how many words the participant missed, changed, or added (were not in the shadowed track); and how many words were spoken in different plurality (either an *s* was added or removed from the end of a word), how many times the participant stuttered and how many times the participant laughed during the task.

Physiological data were analyzed for the middle thirty seconds of each of the five 40-sec segments to minimize the effects of the stimulus change itself. Information from the segments in which the participants' HR, BP, and GSR was measured was calculated using AcqKNOWLEDGE software. Unfortunately, due to equipment failure we only obtained BP data for 16 of 37 participants. Therefore, we have excluded that data from the analysis. For the remaining measures, HR and GSR, the means of each segment were taken, as well as the peak-to-peak value, maximum, and minimum values of GSR.

Data were analyzed using 3-way ANOVAs, measuring the independent variables segment type (3) X parental status (2) X gender (2) by the dependent variables for each measure of attention separately (speech disfluencies while repeating the passage; answers on the recall and recognition test; and physiological responses). In addition, we used chi-square analyses to compare the number of participants who recognized whines and child-

directed speech in the passage.

Results

The results section is separated into 3 parts: speech disfluencies while repeating the shadowed passage; answers on the recall and recognition test; and physiological responses.

Speech Disfluencies when Repeating the Shadowed Passage

Before analyzing the data, we performed two analyses to see if we could reduce the data. The first was a principal components factor analysis using equamax rotation to determine which of the speech disfluencies, if any, loaded together. Two factors emerged with eigenvalues greater than one, accounting for 50.2% of the total variance. The first factor accounted for 32.75% of the variance. We name this factor Linguistic Alterations, which included how many words were missed (loading of .85), added (loading of .78), or changed (loading of .67), during repetition of the shadowed passage. The second factor, which accounted for 17.5% of the variance, included only one variable, how many times participants stuttered (loading of -.83) during repetition of the shadowed passage. For the remainder of the analysis, we combined the values for the linguistic alterations (factor 1) for analysis, and left the number of times participants stuttered (factor 2) as a separate variable. As neither the number of times participants laughed or altered plurality was accounted for in the factor analysis, we have excluded them from further analysis.

The second test was a 3-way ANOVA comparing parental status X gender X condition: neutral one, two, and three segments for speech disfluencies. These neutral segments were those that accompanied the non-shadowed passage before, between, and after the two test segments (whine and CDS). These segments did not differ from each other, nor did they differ based on parental status or gender. Therefore, the three neutral comparison segments were averaged together and are reported below as a unified neutral segment to serve as a control for the test segments.

Linguistic alterations were then analyzed using a 3-way ANOVA, comparing segment type (3) X parental status (2) X gender (2). Since the group sizes in this study are unequal, we were restricted to the less stringent Fisher LSD post-hoc analysis to parcel out condition effects. The ANOVA for differences in linguistic alterations showed significant effects of condition ($F(2, 106) = 14.061, p < 0.001$) and gender ($p = 0.036$), but not an interaction of the two. Males overall made more linguistic alterations than females. Using a Fisher LSD post-hoc analysis, the condition effects showed that participants made significantly more linguistic alterations when listening to the whine segment than the neutral ($p < 0.001$) and CDS ($p = 0.042$) segments. Participants also made more linguistic alterations when presented with the CDS segment than the neutral segment ($p = 0.002$). (See Table 2 for mean values and standard deviations). Parents did not differ from non-parents.

Table 2. Mean Values and Standard Deviations of Differences in Linguistic Alterations Across Segment Types

| Segment Type | Mean Linguistic Alteration | Standard Deviation |
|--------------|----------------------------|--------------------|
| Neutral | 0.42 | 0.03 |
| Whine | 5.05 | 0.97 |
| CDS | 3.24 | 0.51 |

There were no significant differences for factor 2, how many times participants stuttered while repeating the shadowed passage.

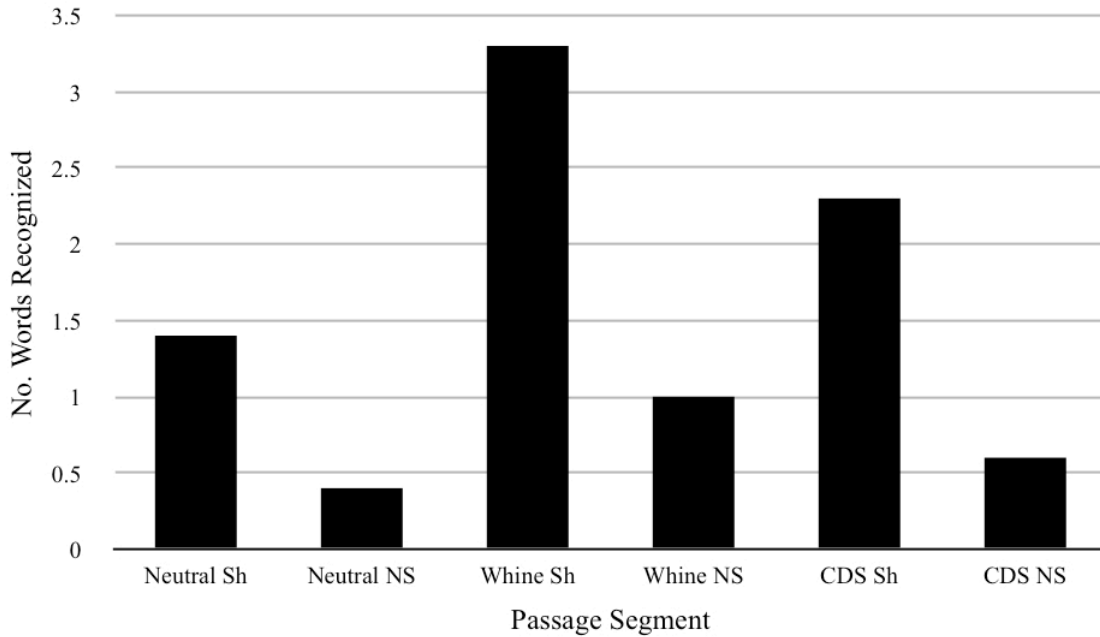
Recall and Recognition Test

The amount of words recognized differed by condition ($F(5, 165) = 30.502, p < 0.001$; see figure 1). In support of our hypothesis, participants recognized more words from the whine segment than the neutral segment from the non-shadowed passage ($p = 0.040$), but there was no significant difference between the CDS segment and neutral segment from the non-shadowed passage. However, in addition to this finding, participants also recognized more words from the shadowed passage when it played along with the whine and CDS segments in the non-shadowed passage than when it played along with the neutral control segment ($p < 0.001$ and $p = 0.003$ respectively). Overall, participants recognized fewer words from the whine ($p < 0.001$) and CDS ($p < 0.001$) segments than from the corresponding shadowed segments.

When asked what distracted them from repeating the shadowed passage, 68% of participants stated whining and only 14% claimed distraction by the CDS. Participants reported hearing whines more often than not, and hearing more whines than CDS ($\chi^2 = 22.42, p < 0.001$). Asking what was distracting directly is not necessarily a clear indication of what actually distracted participants in the moment, but by being able to recall that they heard whining, participants showed that in some ways it attracted their attention. Some of the interesting comments made in reference to the whining track include: “I wanted to be distracted when I heard the whining child, but believe that I carried on nevertheless,” “[I was distracted] by the story in the left ear. By the baby crying ‘I want candy!’ I felt guilty that I could block it out when I did - like blocking it out meant I am a bad dad,” “[I was distracted] by the girl with the loud voice whining (she reminded me of my four-year old daughter),” “It was especially distracting when the voice started whining and making the baby cooing noises.”

These comments show the type of processing that occurred in respect to the whining portion after participants completed the dichotic listening task. Not only did participants recognize and report that whining was included in the non-shadowed passage, but many of them related the stimulus to their own lives. Further, many reported trying harder to ignore the whines than the rest of the story.

Figure 1. Differences in the number of words recognized in passage segments.



Note: The NS (Non-Shadowed) labels refer to what was playing in the ear that the participants were asked to ignore. For example, Whine NS is the recording of a woman whining, while Whine Sh (Shadowed) is the passage participants’ were meant to repeat while the whining played to the other ear.

Physiological Responsiveness

Changes in GSR were analyzed by a 3-way ANOVA comparing segment type (3) X parental status (2) X gender (2) for the mean value of GSR. GSR levels differed based on the segment type alone ($F(2, 91) = 4.808, p = 0.01$). A Fisher LSD post-hoc analysis revealed that GSR increased during the whine segment compared to the neutral segment ($p < 0.01$). GSR was also higher during the CDS segment than the neutral segment ($p = 0.03$). (See table 3 for means and standard deviations).

Table 3. Mean Values and Standard Deviations of Galvanic Skin Response (GSR) Across Segment Types

| Segment Type | Mean GSR | Standard Deviation |
|--------------|----------|--------------------|
| Neutral | -0.0364 | 0.0326 |
| Whine | 0.0129 | 0.0649 |
| CDS | -0.0007 | 0.0862 |

There was no difference in mean heart rate based on segment type or parental status. The only finding is that females overall had a higher average heart rate than males, a common physiological finding.

Discussion

Whines, and to a lesser extent CDS, were effective at capturing the attention of adult listeners in this study for the four measures related to our hypotheses. In addition to our one hypothesis regarding word recognition, whines and CDS both appear to have helped focus the listener's attention more intently on the task at hand. This study, in conjunction with previous studies (Lescak et al., 2006; Sokol et al., 2005; Webster, 2005), establishes whining as a member of the family of attachment vocalizations.

The effectiveness of whines and CDS to attract the attention of listeners was shown in a few ways. As predicted, participants made more linguistic alterations when presented with whines and CDS than neutral, adult-directed speech. Whines in fact appear to be even more effective at getting attention than CDS. Participants made more linguistic alterations when presented with whines than CDS, and also recalled hearing whines in the "ignored" passage more often than they recalled hearing CDS (this study) or even the presence of their own names (previous studies: Cherry, 1953; Wood and Cowan, 1995). This finding echoes a previous study, in which participants were more distracted by whines than infant cries or CDS when asked to complete simple math problems (Sokol and Thompson, 2005). Finally, in the current study, participants showed an increase in Galvanic skin response when listening to whines and CDS relative to listening to neutral speech. Though a less direct measure of attention, physiological response indicates an attentional, if unconscious, shift in a person's focus.

On first glance, one might wonder why the whines in this study were shown to be more effective than CDS at attracting attention. After all, there is an extensive literature that confirms that CDS is an effective attention-getter. However, CDS is designed to attract the attention of infants and young children, and perhaps in some instances pets and spouses. Whines, on the other hand, have been designed to attract the attention of caregivers. As such, the results of this study are not surprising – whines should be more effective at getting the attention of adult listeners than CDS.

However, the converse might not be true – whines might also be more effective at getting the attention of at least older children than CDS. Whining begins at a time when children are increasingly cared for by alloparents, which traditionally includes older siblings, both parents, grandparents, aunts, and uncles (see Hrdy, 2009 for a review). In this study we have shown that whines attract the attention of all listeners, regardless of whether those participants are male, female, or have children (see also Sokol and Thompson, 2005 for a similar finding related to distraction). Whines are effective at eliciting attention from more than mom – and indeed, in traditional societies, maternal grandmothers, and even older female siblings engaged in childcare have a beneficial effect on child survival (Sear and Mace, 2008). Thus a future study might examine children of different ages in a similar attention task.

One of the measures of attention in this study, the ability to recognize words from the passages, added an interesting twist to our findings. While participants recognized more words from the whine than the neutral non-shadowed passage, they also recognized more words from the shadowed passage that played in conjunction with the whine and CDS passages than the neutral passage. The finding is in conjunction with dichotic listening studies, where participants are much more likely to recall changes in voice (such as from a male to female voice) than specific verbal content (Treisman, 1960). Therefore, that

participants recalled the changes in voice (e.g. switch to whining or CDS) and not the words in those passages is no surprise. Further, as a distress signal, whines are more likely serving the function of creating an immediate response on the part of a caregiver, who then has no need to store the details of the whine event. Remembering the words associated with a whine bout would not be necessary.

That whines and CDS both appeared to have an attention-directing function for the recall of words could be interpreted in a few ways. One is that participants were actually drawn to the whine and CDS segments, and as a result tried even harder to stay with the task at hand, shadowing the “shadowed” passage. One of the participant’s comments reported in the results, about *wanting* to be distracted by the whining child, but still carrying on with the task, supports such speculation. Perhaps the whine and CDS segments initially captured the attention of listeners, who then struggled to attend more intently to the task at hand.

A more evolutionarily informed explanation for why people recall hearing whines, but recognize more words from the competing task while listening to whines is that whines are a way for children to show deference to caregivers while pleading for resources. Puts, Gaulin, and Verdolini (2006) examined the role of pitch for men in dominance encounters. They found that men raise the pitch of their voices to show deference in dominance challenges. Across cultures, people raise pitch to signal a lack of threat (e.g. when being polite), while lowering pitch to signal assertiveness (Ohala, 1983; 1984). Raising pitch is similar to whimpering or whining in dogs, a vocalization that also occurs in an act of deference. For example, domesticated dogs will whimper when attacked, even when the attack does not result in a wound (Shyan, Fortune, and King, 2003). In such encounters, submissive behaviors continue to solidify ongoing relations, rather than communicate a particular content. Thus whines might function to signal submissiveness on the part of the child, while the content of what is being said is less important.

There are some possible limitations to the current study, the first being the possible ability of loud sounds to attract attention in general. Increased amplitude is one acoustic variable of whining (Sokol et al., 2005) and thus one could argue that the loudness of the whine alone was what attracted the attention of listeners in this study. We disagree with this assumption for two reasons. The first is that CDS was also more effective at eliciting the attention of listeners, and increased amplitude is not a feature of CDS. The second is that in a previous study (Sokol and Thompson, 2005), we found that whining was more effective at getting the attention of listeners than machine noise, which also was loud with sounds of a saw getting caught on knots of wood. Whines are more than the amplitude they display.

The second possible limitation is that our measures of attention were indirect measures of investment. While we show here that people have attentional shifts in response to whining when completing a relatively simple cognitive task, we have not shown that whines are more effective at attracting the attention of busy caregivers than, say, screaming or crying. An ethological examination of the types of methods children employ to get a caregiver’s attention, and the response of the caregiver would be an important extension of the current study.

One related future study could help disambiguate the relationship between whining and parental investment. One variable parents might continue to track is the nutritional independence of its offspring. To the extent that whining is a sign of lack of readiness for independence, parents might continue to be selected for being vulnerable to it. However, to

the extent that whining is a simulation of nutritional dependence unconnected to the health status, adults might be selected for ignoring it. More research is needed on the variations in the deployment of whining and parental responses to it to disambiguate its relation to parental investment.

Whining appears to be a useful way to both get the attention of listeners and manipulate the proximity of attachment partners. Previous studies have explored the structural similarity of whines to infant cries and CDS (Lescak et al., 2006; Sokol et al., 2005; Webster, 2005). This study has added to other findings (Sokol and Thompson, 2005) that show the functional similarity of whines to infant cries and CDS. We feel that such findings support the assertion that whines, cries, and CDS all utilize a specific acoustic structure designed to exploit an auditory sensitivity shared among humans.

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References

- Best, C. T., Womer, J. S., and Queen, H. F. (1994). Hemispheric asymmetries in adults' perception of infant emotional expressions. *Journal of Experimental Psychology: Human Perception and Performance*, 20, 751–765.
- Borba, M. (2003). *No more misbehavin': 38 difficult behaviors and how to stop them*. San Francisco: Jossey-Bass.
- Bowlby, J. (1969/1982). *Attachment*. New York: Basic Books.
- Brewster, A., Nelson, J., McCanne, T., Lucas, D., and Milner, J. (1998). Gender differences in physiological reactivity to infant cries and smiles in military families. *Child Abuse and Neglect*, 28, 775–788.
- Cherry, C. (1953). Some experiments on the recognition of speech with one and two ears. *Journal of the Acoustical Society of America*, 25, 975–979.
- Corteen, R. S., and Wood, B. (1972). Autonomic responses to shock-associated words in an unattended channel. *Journal of Experimental Psychology*, 94, 308–313.
- Crowe, H. P., and Zeskind, P. S. (1992). Psychophysiological and perceptual responses infant cries varying in pitch: Comparison of adults with low and high scores on the Child Abuse Potential Inventory. *Child Abuse and Neglect*, 16, 16–29.
- Dessureau, B., Olson, C., and Thompson, N. S. (1998). A reassessment of the role of pitch and duration in adults' responses to infant crying. *Infant Behavior & Development*, 21, 367–371.
- Falk, D. (2009). *Finding our tongues: Mothers, infants and the origins of language*. New York: Basic Books.
- Fernald, A. (1992a). Meaningful melodies in mother's speech to infants. In U. J. Hanus-Papoušek and M. Papoušek (Eds.), *Nonverbal vocal communications* (pp.262–282). New York: Cambridge University Press.
- Fernald, A. (1992b). Human maternal vocalizations to infants as biologically relevant

- signals: An evolutionary perspective. In L. Cosmides, J.H. Barkow, and J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 391–428). New York: Oxford University Press.
- Fernald, A. (1993). Approval and disapproval: Infant responsiveness to vocal affect in familiar and unfamiliar languages. *Child Development, 64*, 657–674.
- Fernald, A., and Mazzei, C. (1991). Prosody and focus in speech to infants and adults. *Developmental Psychology, 27*, 209–221.
- Forster, P. M., and Govier, E. (1978). Discrimination without awareness? *Quarterly Journal of Experimental Psychology, 30*, 282–295.
- Gogate, L. J., Bahrick, L. E., and Watson, J. D. (2000). A study of multimodal child-directed speech: The role of temporal synchrony between verbal labels and gestures. *Child Development, 71*, 878–894.
- Gustafson, G. E., and Green, J. A. (1989). On the importance of fundamental frequency and other acoustic features in cry perception and infant development. *Child Development, 60*, 772–780.
- Hrdy, S. B. (2009). *Mothers and others: The evolutionary origins of mutual understanding*. Cambridge, MA: Harvard University.
- Kearsley, R. (1973). The newborn's response to auditory stimulation: a demonstration of orienting and defensive behaviour. *Child Development, 44*, 582–590.
- LaGasse, L.L, Neal, A.R., and Lester, B.M. (2005). Assessment of infant cry: Acoustic cry analysis and parental perception. *Mental Retardation and Developmental Disabilities Research Reviews, 11*, 83–93.
- Lescak, E. (2006). Physiological and self-reported responses to attachment vocalizations. Undergraduate Honor's Thesis, Clark University.
- Lescak, E., Green, J., Cohen, J., Eaton, B., Simonson, M., Sokol, R. I., and Thompson, N. S. (Apr., 2006). Physiological and self-reported responses to whines. Poster presented at Clark University's Academic Spree Day.
- Mazzoni, D. (2004). Audacity 1.2.3. <http://audacity.sourceforge.net/>
- Mumme, D. L., Fernald, A., and Herrera, C. (1996). Infants' responses to facial and vocal emotional signals in a social referencing paradigm. *Child Development, 67*, 3219–3237.
- Ohala, J. J. (1983). Cross-language use of pitch: an ethological view. *Phonetica, 40*, 1–18.
- Ohala, J. J. (1984). An ethological perspective on common cross-language utilization of F0 of voice. *Phonetica, 41*, 1–16.
- Papoušek, M., Bornstein, M. H., Nuzzo, C., Papoušek, H., and Symmes, D. (2000). Infant responses to prototypical melodic contours in parental speech. In D. Muir and A. Slater (Eds.), *Infant development: The essential readings in developmental psychology* (pp. 261–268). Malden, MA: Blackwell Publishers.
- Puts, D. A., Gaulin, S. J. C., and Verdolini, K. (2006). Dominance and the evolution of sexual dimorphism in human voice pitch. *Evolution and Human Behavior, 27*, 283–296.
- Robb, M. P., Saxman, J. H., and Grant, A. A. (1989). Vocal fundamental frequency characteristics during the first two years of life. *Journal of Acoustical Society of America, 85*, 1708–1717.
- Sear, R., and Mace, R. (2008). Who keeps children alive? A review of the effects of kin on

- child survival. *Evolution and Human Behavior*, 29, 1–18.
- Sears, W., and Sears, M. (1995). *The discipline book: How to have a better behaved child from birth to age ten*. New York: Little, Brown & Co.
- Shapiro, K. L. (1994). The attentional blink: The brain's "eyeblick." *Current Directions in Psychological Science*, 3, 86–89.
- Shyan, M. R., Fortune, K. A., and King, C. (2003). "Bark Parks" – A study on interdog aggression in a limited-control environment. *Journal of Applied Animal Welfare Science*, 6(1): 25–32.
- Sokol, R. I., and Thompson, N. S. (2005, June). Children's whining: The adaptive pleas of an attachment vocalization. Paper presentation at the 17th Annual meeting of the Human Behavior and Evolution Society, University of Texas at Austin, TX.
- Sokol, R. I., Webster, K. L., Thompson, N. S., and Stevens, D. A. (2005). Whining as mother-directed speech. *Infant and Child Development*, 14, 478–490.
- Thompson, N. S., Dessureau, B., and Olson, C. (1998). Infant cries as evolutionary melodrama: Extortion of deception? *Evolution of Communication*, 2, 25–43.
- Thompson, N. S., Olson, C., and Dessureau, B. (1996). Babies' cries: Who's listening? Who's being fooled? *Social Research*, 63, 763–784.
- Trainor, L. J., Austin, C. M., and Desjardins, R. N. (2000). Is infant-directed speech prosody a result of the vocal expression of emotion? *Psychological Science*, 11, 1–8.
- Treisman, A. (1960). Contextual cues in selective listening. *Quarterly Journal of Experimental Psychology*, 12, 242–248.
- Trivers, R. L. (1974). Parent-offspring conflict. *American Zoologist*, 14, 249–264.
- Virtual Language Centre (2010). Words listed by frequency: The first 2000 most frequent words from the Brown Corpus (1,015,945 words). Retrieved May 10, 2010, from <http://www.edict.com.hk/lexiconindex/frequencylists/words2000.htm>.
- Webster, K. (2005). An evolutionary approach to prosody: Comparing whining and motherese. Honor's thesis, Clark University.
- Wood, N., and Cowan, N. (1995). The cocktail party phenomenon revisited: How frequent are attention shifts to one's name in an irrelevant auditory channel? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 255–260.
- Zeskind, P. S., and Lester, B. M. (1978). Acoustic features and auditory perceptions of the cries of newborns with prenatal and perinatal complications. *Child Development* 49, 580-589.
- Zeskind, P., and Shingler, E. (1991). Child abuser's perceptual responses to newborn infant cries varying in pitch. *Infant Behavior and Development*, 14, 335–347.